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# A SIMPLE WAY TO INCREASE CROP YIELDS

THE SOILS of the coastal plain area of the Central Atlantic States, as a rule, are light in character, have been farmed for generations, and need first of all a liberal supply of organic matter. This need should be met by growing such legumes as crimson clover, cowpeas, soybeans, red clover, and hairy vetch. Rye, buckwheat, and the grasses are also valuable in meeting this requirement.

Commercial fertilizer and lime should be used freely when they are needed to stimulate the growth of these soil-improving crops.

By arranging the cropping system to include one or more legumes that supply the land with nitrogen and humus, crop yields have been greatly increased on many farms scattered throughout this area. The systems followed on a few of the more successful of these farms are described in detail in this bulletin.

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# A SIMPLE WAY TO INCREASE CROP YIELDS

## Methods followed by farmers of the coastal plain section of the Central Atlantic States in building up soil fertility

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THE COASTAL PLAIN sections of New Jersey, Maryland, Delaware, and Virginia constitute one of the oldest farming areas in the Central Atlantic States. Much of the cleared land has been farmed continuously since the area was settled more than 200 years ago. As a rule, the cropping systems and methods of farming followed in the past have not provided for maintaining fertility, and in some localities a relatively large part of the farm lands do not produce yields large enough to make farming profitable. During more recent years, however, more attention has been given to improving the farm lands, much of the soil has been built up in fertility, and many farms are now producing more than double the crop yields they produced before.

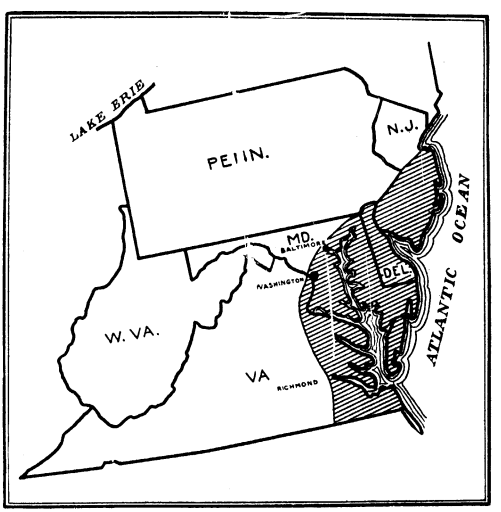


FIGURE 1.—Map of coastal plain section of Central Atlantic States

### ECONOMIC AND SOIL CONDITIONS

The coastal plain area of the Central Atlantic States is especially well located geographically in nearness to several important centers of population that consume large quantities of farm products. A market for the great variety of crop and livestock products to which

the climate and soil are so well adapted is therefore within easy shipping distance.

Transportation is provided by rail, water, and motor truck. A large part of the area is served by railroads and in many cases the main lines reach the larger cities directly, and this permits marketing perishable products with little or no delay. Chesapeake Bay and its tributaries afford water transportation to a large part of the area. Hard-surfaced roads and nearness to many large markets have made the motor truck important in the transportation of farm products.

The farm land is made up of a great variety of soils, ranging from sands and sandy loams with light subsoil to silts and silt loams and clay loams with heavier subsoils. The natural productiveness of these soils differs greatly. Some need special treatment at the start to make them productive; others are productive for a few years, but are soon depleted unless provisions are made for maintaining fertility; other soils have been farmed continuosly for a great many years and are still producing good crops.

This variation in character of soil in different parts of the area and the demand for different farm products by the cities have resulted in the production of a wide diversity of crops. Farms located on the lighter, sandier soils are devoted mostly to growing truck and small fruits, and farms on the heavier land produce corn, wheat, hay, and livestock products. The combined effect, therefore, of soil conditions and market demands has been largely responsible for the development of types of farming that do not include much livestock, but emphasize the production of cash crops for sale on the market. This development has resulted in the use of large quantities of commercial fertilizer. This practice, in a measure, has retarded the development of other important methods of soil maintenance.

As a rule, the farmers of this area have given comparatively little attention to methods of soil management. Even now, in many localities, legumes are not generally grown and winter cover crops are practically unknown. In many cases the same crop has been grown year after year on the same land with little or no provision for maintaining fertility except through the use of small quantities of commercial fertilizer. This lack of attention on the part of the farmers has resulted in poor yields and an unproductive condition of the soil on many farms.

At present, the situation with respect to crop production in this area is as follows: The stronger and naturally more fertile soils are still producing good crops and probably will continue to do so for many years. Other soils that have been built up by improved methods of soil management to a high state of fertility are also productive. By far the greater portion of the area, however, is returning crop yields, so small that they are responsible for placing many farms on the border line between a profitable and a losing business. There is also a considerable extent of land that is decidedly unproductive and some that for this reason is not farmed at all. Since crop yield is one of the more important single factors in determining the profits from farming, it is of the utmost importance to the agriculture of the area that the fertility of these poorer producing lands be improved.

The first step toward solving the problem of these poor lands is perhaps the most difficult—the building up of soil fertility to a point at which it will produce yields large enough to put farming on a paying basis. Fortunately, there are many examples of farms in this area that have been made more productive because the farmers adopted improved methods of management that may well serve as guides in building up soil fertility and obtaining better crop yields on other poor farms.

## IMPORTANT FACTORS IN SOIL IMPROVEMENT

On account of the differences in the character of the soil and the great variety of crops that are grown in the area, there is much diversity in farm practice, not only in methods of tillage but also in the use of fertilizers and in other methods of soil improvement. There is one outstanding feature, however, in all of these different methods of building up land—the fact that in every case where the fertility of the soil has been built up and crop yields have been materially increased, large quantities of vegetable matter have been added to the soil in one form or another.

Commercial fertilizers and tillage practices play an important part in crop production, but the general results that have been obtained indicate that humus is one of the most important factors in the improvement of the soil of this area and that crop production depends largely upon the quantity of decayed vegetable matter in the soil. On some of the poorer, low-yielding land, for example, a good growth of crimson clover turned under doubles the yield of the succeeding crops. In many instances farmers have plowed under three crops of crimson clover in succession and have brought their land up from a condition in which it produced only 15 bushels of corn per acre, to a point at which it produced more than 50 bushels per acre. This indicates that as the organic matter is increased in these soils, the yields also increase.

The presence of organic matter benefits these lands in several ways. It increases the bacterial activity so essential to crop production. It causes water to be absorbed more readily during heavy rains, and thus lessens the danger from washing. Soils well supplied with organic matter are more retentive of moisture, remain more friable, are easier to work, and are less likely to become hard or form a crust after rains. The chief source of nitrogen in the soil is the breaking down and decay of organic matter present, and nitrogen is one of the most expensive fertilizers that the farmer must buy.

The big problem in the improvement of farm land in this area is to get organic matter into the soil and to do it economically. In the farm practice of the area there are three principal sources from which humus is usually supplied—farm manure, roots and stubbles left from crops, and green crops turned under.

## FARM MANURES

Farm manure is a most valuable source of fertility on many of the farms. In addition to supplying considerable nitrogen, some phosphoric acid, and potash, it is an important source of humus. In parts of this area where the type of farming includes livestock enterprises,

the manure from the animals and the sod remaining from the clover and grass crops are the chief reliance for maintaining the supply of organic matter in the soil. On the heavier soils, and especially on livestock farms where a large part of the land is kept in sod, the manure produced is usually sufficient to maintain the organic matter necessary to good crop production. But on some of the lighter land it is difficult to maintain the normal supply of organic matter even on farms heavily stocked with animals and where all crops are fed. On such lands especially it is necessary not only to use all the available manure but to increase still further the organic matter in the soil by turning under crop residues and green crops.

The importance of supplementing the farm manure with organic matter from other sources is well illustrated by the results obtained on a dairy farm located on light sandy land in Anne Arundel County, Md. The crops grown were corn and cowpeas in a 2-year rotation. Two hundred pounds of acid phosphate per acre were ap-

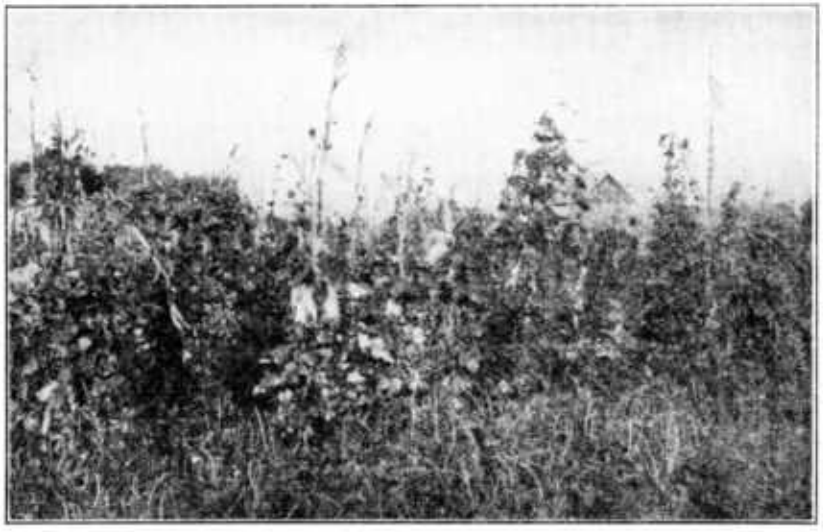

FIGURE 2.—Sixty bushels of corn per acre and a large amount of organic matter to be returned to the soil

plied to each crop. In addition to the roughage produced by the corn and cowpeas, grain was bought and fed to the cows. In spite of the fact that all of the manure thus produced by the cows and work stock was returned to the land, the crop yield steadily declined until the cropping system was rearranged to provide a greater quantity of organic matter in the soil. This was accomplished by sowing crimson clover in the corn and plowing it under for the cowpeas.

## CROP RESIDUES

The roots and stubble left in the soil after crops are harvested constitute an important source of organic matter. The quantity of this material left from such crops as corn and wheat harvested in the usual way is not large; but where systems of management which leave practically the entire crop on the field are followed,

the quantity of organic matter thus added is much greater. Pasturing off crops with livestock is an economical way of removing the crops and adding large quantities of organic matter to the soil. Figure 2 shows the possibilities of this method.

The corn crop shown in this illustration was husked from the stalk and livestock was turned in to pasture on the peas and cornstalks.

Supplying organic matter by methods which turn back as great a quantity of crop residue as possible ordinarily does not receive sufficient attention on the average farm of the area. The cropping system that does not provide for maintaining an abundance of organic matter in the soil is of little value in building up fertility. Merely alternating the crops is not sufficient. Hay and pasture land should be plowed while there is still a good sod. Weeds, cornstalks, straw, and other material of this kind are valuable sources of organic matter. In addition, the system should provide either for pasturing off crops with livestock or turning under green crops regularly in the rotation.

## SOIL-IMPROVING CROPS

The types of farming that prevail in the coastal plain area do not include much livestock except the necessary work animals. As a result little manure is available for soil improvement on the average farm and most farms must rely on other sources for the organic matter necessary to keep the land in a productive condition. Most of the progress in building up the low-yielding soils has been made by arranging the cropping systems to include one or more crops to be turned under at regular intervals. In some instances it has been necessary to plow under several crops before sufficient fertility could be accumulated to produce yields large enough to be at all profitable. This involves considerable expense, but in extreme cases it is doubtless good practice.

In using green-manure crops as a means of soil improvement it is of distinct advantage to use legumes so far as possible. These crops add to the organic matter and supply large quantities of nitrogen, the most expensive element that is bought in the form of commerical fertilizers. If legumes are grown regularly and are plowed under on the different fields, the nitrogen required for the growth of the other crops will be supplied and much money may be saved which would otherwise have been expended on fertilizers.

### COWPEAS

Cowpeas are one of the best-known crops in the area and one of the first to be used for soil improvement. This crop possesses several advantages over most others. It probably will grow on poorer soil and give better results in extreme cases of soil depletion than any other crop now used for soil improvement in the area. It is advisable, generally, to begin building up the soil first by growing cowpeas, because they can be grown with simple treatment and little expense in preparation. Cowpeas do well without lime or inoculation, and respond readily to the application of small quantities of fertilizer.

Cowpeas are grown in a number of ways and for a number of purposes, but however used they are valuable in the improvement of the soil. Occasionally the crop is plowed under, but it is more generally grown for hay. In some instances seed is produced and sold as a cash crop. Another plan which offers considerable opportunity for soil improvement is to sow cowpeas in the corn at the last cultivation. Grown in these various ways, cowpeas are capable of improving the land until it will produce a wider variety of crops.

### SOYBEANS

The acreage of soybeans has steadily increased and in some sections of the area this crop has taken first place among the leguminous crops grown for hay, for seed, and for hogging-down. Soybeans have largely replaced cowpeas as a crop in standing corn, mainly because they make better yields, are more readily harvested by machinery, and are less likely to interfere with the harvesting of the corn crop. Soybeans are not grown to any extent to be turned under because the crop is usually considered too valuable for seed and forage purposes to be plowed under for soil improvement. The nitrogen and organic matter, left to the soil by the roots and stubble after the crop is harvested, play an important part in maintaining soil fertility. When the crop is hogged-down a much larger part of the total vegetable matter is returned to the soil.

Although similar to cowpeas with respect to growing season and the place occupied in the cropping system, soybeans as a rule are more desirable because they produce larger yields of both seed and forage except on very thin land. Probably no other crop grown in the area is so well adapted as cowpeas for starting the improvement of very thin land. But once the land is somewhat built up in fertility most farmers prefer to change to soybeans.

### CRIMSON CLOVER

Throughout the area crimson clover stands out as one of the more valuable crops for soil improvement. In addition to being an excellent crop to be plowed under as a green manure, it is valuable for early spring grazing and for hay. Sown in the late summer or early fall, it occupies the land during the winter, serves as a cover crop, and protects the soil from washing and leaching during the fall, winter, and spring seasons, a matter of great importance in this area, where the winters are generally mild, with frequent rains. The expense of seeding is usually but little more than the cost of the seed, and many farmers are now growing their own seed.

Crimson clover can be grown in this area in several ways. It may be seeded alone in August and September, or in the corn at the last cultivation. It is common practice to sow it in July with a nurse crop, usually buckwheat.

In beginning to improve the poorer land in the coastal plain area cowpeas should be grown before attempting to get a stand of crimson clover. The beneficial influence of the cowpeas does much to insure success with the crimson clover. The application of from 200 to 300 pounds of acid phosphate per acre is likewise of great importance in starting crimson clover on poor land. In all cases

the seed should be covered lightly instead of sowing on the surface and trusting to rains to effect a covering.

Until the soil is built up slightly and the few special requirements just mentioned are complied with, it is more difficult to grow crimson clover than it is to grow cowpeas, but the great value of crimson clover and the place it fills in the cropping system and which can not be filled by cowpeas and some of the other legumes make it highly important that crimson clover be grown regularly in the cropping system. Figure 3 shows how luxuriantly crimson clover grows on some of the poorer lands of this area after some of its requirements have been met.

### LESPEDEZA

Most farmers in the area under discussion are familiar with the habits and growth of the small naturalized Lespedeza, commonly called Japan clover, found growing in fields and waste places from

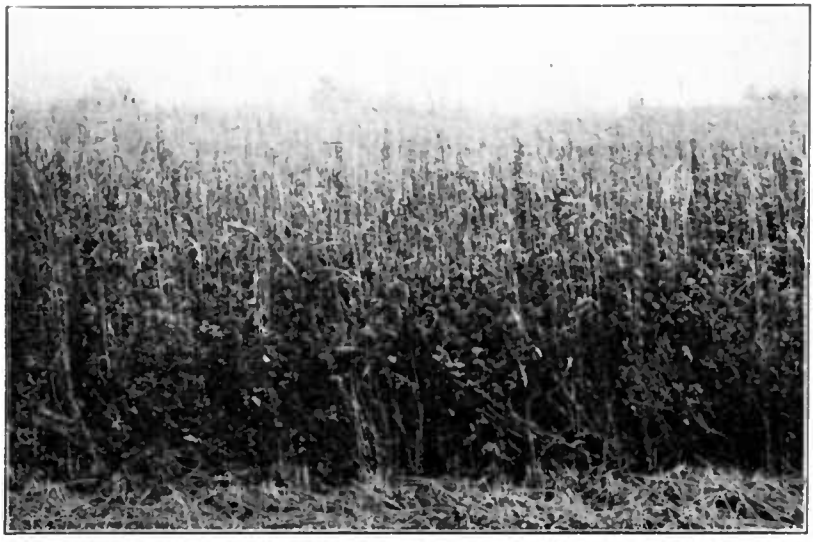

FIGURE 3.—Crimson clover is one of the most valuable crops grown in the area. It is shown here growing with rye

southern Pennsylvania and New Jersey southward. This variety, except under very favorable conditions, does not grow tall enough in the Central Atlantic States to be of much importance as a hay crop but is of considerable value for pasture and soil improvement. Recent introductions of larger-growing varieties of Lespedeza have greatly increased the use of this plant as a farm crop.

The variety most generally grown in the Central Atlantic States is known as Korean Lespedeza. This, like the common Lespedeza, is an annual and produces an abundance of seed. Korean Lespedeza is sown in the spring either alone or with small grains, usually oats. When sown alone it is ready to be cut for hay in August and the second growth can be pastured, turned under to enrich the soil, or left to reseed the land. Sown with oats it can be pastured

after the oat crop is cut, turned under for soil improvement, or allowed to reseed the land for hay or pasture the following year. A good rotation is: Corn, small grain, Lespedeza one or two years. The Lespedeza is sown on the small grain in the spring in much the same way that red clover is sown.

Lespedeza does well on almost any well-drained land; but like many other crops, it makes a better growth on the more fertile loams. When it is sown on thin land for hay or for soil improvement a liberal application of commercial fertilizer will materially increase its growth. Although Lespedeza will grow without lime, much better results have been obtained by applying a small quantity of lime, 400 to 500 pounds per acre, at the time of seeding. This small quantity at that time seems to have a beneficial effect on the young plants and better stands have been secured by this method.

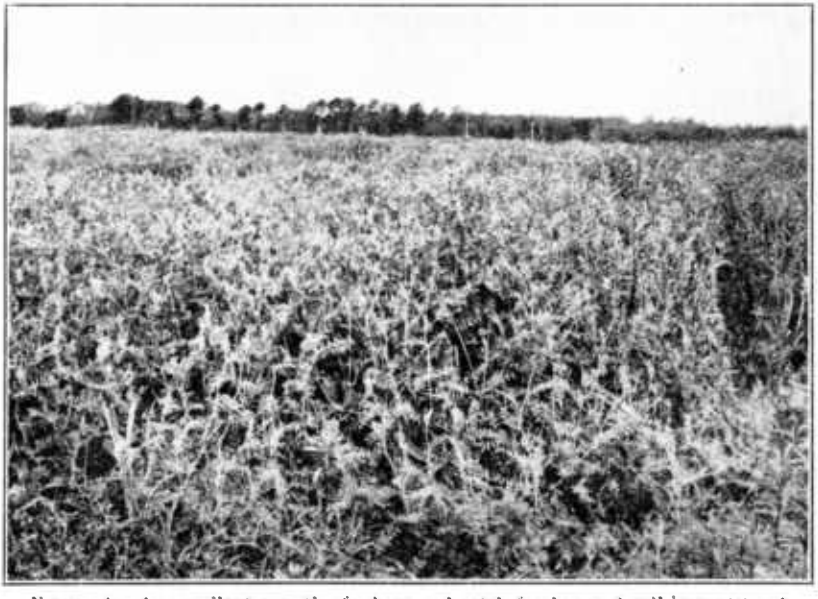

FIGURE 4.—An excellent growth of wheat and vetch for hay and soil improvement

VETCH

Hairy vetch is well adapted to the soil and climatic conditions of the area; but on account of lack of information on methods of growing and using the crop, it is not grown generally. The marked success by a great many farmers who grow vetch regularly warrants a more general use of this crop for soil improvement. Sown with grain in the fall, it has the advantage of being more hardy than crimson clover and can therefore be sown much later in the season without danger of winterkilling. This crop, like crimson clover, occupies the land during the fall, winter, and spring, acting as a cover, and conserves soil fertility. The mixture of vetch and grain is usually cut for hay in May, depending on the grain with which it is sown. After the hay is cut the land can be planted to corn, cowpeas, soybeans, or tomatoes. This makes the crop a valuable

addition to the ordinary cropping system of the region. As shown in Figure 4, vetch produces a good growth of hay and a large amount of organic matter to be plowed under.

The methods of growing vetch are comparatively simple. The seed is usually mixed with grain and sown with a drill at the rate of about 30 pounds of vetch to 1 bushel of wheat or rye per acre. It has been the usual practice to sow this crop without paying much attention to inoculation. In some parts of the area it is advisable to inoculate the seed to insure a good growth.

### RED CLOVER

On the lighter soils red clover is not commonly grown; but on the heavier types, where the cropping system usually includes small grain, red clover is of considerable importance. It occupies a very different position in the cropping system from that of any of the crops referred to above. It is usually sown in the spring on small grain and comes to maturity the following year, being used either for hay or pasture. In many instances crimson clover is used in the same cropping system with ordinary red clover; but on land that produces red clover without difficulty, crimson clover is not grown to any great extent. Light applications of lime have been found very beneficial in promoting the growth of red clover on the heavier soils. The application of lime and an increase in organic matter usually makes it possible to grow red clover successfully on many of the lighter soils.

### RYE

Rye is used in many different ways in this area. It is especially well adapted as a winter cover crop because it can be sown at almost any time during the fall and early winter without danger of winter-killing. As soon as growth starts in the spring it can be pastured for four to six weeks and then allowed to grow up to be turned under as a green manure. A mixture of rye and crimson clover is sowed in many instances and usually gives better results on thin land than either of these crops sown alone. With a crop such as rye always at hand and seed at a reasonable price, there is little excuse for any of the farm land in this area to be without a cover during the winter.

### BUCKWHEAT

Buckwheat is used to great advantage in soil improvement. It is a convenient crop to manage, as it can be sown at almost any time during the growing season and is ready to turn under about eight weeks after being planted. The short growing period required allows buckwheat to be grown after other crops are removed, and to be turned under before late-planted crops need be planted. As it is not a legume, the main advantage of buckwheat in soil improvement is the addition of organic matter. In many parts of the area the usual practice is to sow buckwheat and crimson clover in July. The buckwheat is allowed to mature and is harvested for the grain, and the crimson clover then has full possession of the land for the remainder of the year. This practice reduces the expense of sowing the crimson clover, since the return from the buckwheat crop usually

is sufficient to pay the expense of the entire operation. The fact that the crimson clover is sown early and makes a good growth before cold weather sets in is a distinct advantage from the soil-improvement standpoint.

### COMMERCIAL FERTILIZERS

Farmers of the area who are getting the best results from the use of fertilizers, especially those who are growing general farm crops, are maintaining a high percentage of organic matter in the soil and are fertilizing from the standpoint of the needs of the soil in general rather than the fertilizer requirements of the individual crops. Except for potatoes and truck crops, it is wise economy to use commercial fertilizers in a definite plan of permanent soil improvement rather than to make light applications principally for the purpose of stimulating the one crop to which they are applied. It is doubtless good business practice to apply fertilizers to a crop and thus increase the production over and above the cost of the fertilizers and the extra labor, but it is still better to accomplish this in such a manner as to effect a more permanent improvement of the soil, which will serve to benefit several crops in succeeding seasons.

The soils of the coastal plain of the Central Atlantic States need nitrogen and humus first of all. The full effect of fertilizers can not be realized on the average soil of the area until this need has been met. After this the application of phosphorous is of great importance and, on the lighter soils especially, the application of potash is distinctly beneficial. The nitrogen is most economically supplied by growing legumes and turning under crops. Phosphorous is usually supplied in the form of superphosphate (acid phosphate). For general purposes potash is best supplied through the use of muriate of potash or kainit. Under normal conditions, if sufficient attention is given to maintaining the nitrogen supply in the soil, most satisfactory results are obtained by the use of a fertilizer containing both phosphorus and potash. Such a fertilizer can be either purchased on the market or mixed on the farm.

The fertilizer practice that has given best results on most of the farms follows the general plan of applying the fertilizer to the crop that is grown especially for soil improvement. Two or three hundred pounds of superphosphate, for instance, applied to crimson clover that is to be turned under for corn, gives much better returns under the average soil conditions than does the same quantity applied directly to the corn crop. Many of the best farmers are now applying the fertilizer to the legumes and grass crops grown to supply the nitrogen and organic matter necessary to the building up and maintenance of fertility in the soil. The same principle holds good in the application of manure. Manure applied on grassland one or two years before the land is plowed for corn increases the growth of grass, makes more hay and pasture and a better sod, and hence more organic matter to be plowed under. Such a practice is usually better and the effect more lasting than applying the manure during the preparation of the land for the corn crop.

The soils of the area rather generally need lime, in addition to the fertilizing elements that are used. Lime is especially beneficial in

growing red clover, alfalfa, and vetch. Its effect is good on crimson clover, but its use is not absolutely necessary. Soybeans and cowpeas usually grow well on most of these soils without the application of lime. Although an application of lime is generally beneficial in growing legumes and assists in the improvement of the soil, it is often difficult to tell whether lime or organic matter is needed more. In numerous instances the beneficial effects attributed to lime on especially poor soils are secured with equal effectiveness by adding large quantities of organic matter. In general farm practice in this area it is better to begin by growing such legumes as thrive on extremely poor soils and to first build up the organic matter and nitrogen by plowing these crops under.

In many instances it is found that a profitable system of farming can be established and clover and such crops as have previously refused to grow satisfactorily can be grown to good advantage by incorporating humus without applying lime. If, however, after the organic matter in the soil has been materially increased by the use of such crops as crimson clover, soybeans, rye, and buckwheat, the need of lime is indicated, it should be supplied by applying ground limestone or ground oyster shells. A farmer can determine whether his land needs lime by liming a small part of a field to see whether it increases the growth of his soil-improving crops, especially the clovers and grasses.

### CROPPING SYSTEMS

Comparatively few farmers in this area follow a definite crop rotation. Although a fixed rotation is in many respects very desirable from the standpoint of soil improvement, it is not absolutely necessary and in many cases not desirable. Most farmers prefer to follow a cropping system that is more or less flexible so that a shift in the order of cropping can be made when a change in prices or variation of seasons make a change necessary.

In beginning the improvement of land it is generally preferable to start with a more or less definite succession of crops which may later be changed to a system more suited to the type of farming that is being followed. On the poorer lands the best results are obtained by starting with a system of cropping that emphasizes the growing of crops for the express purpose of increasing the organic matter in the soil. The following is a good example:

| | |
|---|---|
| First year | Cowpeas followed by rye. |
| Second year | Cowpeas followed by crimson clover. |
| Third year | Corn followed by crimson clover. |

In the first year under this plan the cowpeas are plowed under and rye is sown in the fall. The rye is allowed to grow until about May 1 of the next spring when it is plowed under in preparation for the cowpea crop of the second year. The cowpeas of the second year may be either plowed under or cut for hay, the former being preferable, as it will further hasten the soil improvement. In the fall of the second year crimson clover is sown for the first time. Generally, by this time the soil has been sufficiently improved so that by the use of some fertilizer a reasonably good stand of crimson clover can be obtained. The crimson-clover crop is permitted to grow until about May 1 of the third year, when it is plowed in preparation

for the corn crop. It is advisable, also, at the last cultivation of the corn crop of the third year to sow crimson clover for hay or to be plowed under the next season in preparation for other crops. The process of soil improvement by this plan of cropping may be made still more effective by applying 200 to 300 pounds of commercial fertilizer per acre on the cowpeas.

On lands that are not extremely run down, and that are still producing fair crops of corn, such radical measures will not be necessary. In many cases a legume or other humus-forming crop can be included in the cropping system, without much extra expense. Under some conditions—as, for instance, on the farms that grow a variety of small fruit and truck crops—it is desirable to grow the same crop continuously on the same land. This is especially true of corn. There are a number of examples of this being done successfully under the following plan of cropping:

| | |
|---|---|
| First year | Corn with crimson clover sown at last cultivation. |
| Second and succeeding years | Crimson clover turned under and corn again planted. Crimson clover sown at last cultivation. |

Under ordinary conditions the yield of corn can not be maintained continuously one year after another on the same land, but under this system, especially with the application of small quantities of fertilizers each year, the yields are being maintained and even increased. By plowing down a crop of crimson clover each year the supply of organic matter is maintained at a high point, and corn can be grown by this system continuously so long as root lice or corn diseases do not make the program impracticable. If that happens, it becomes necessary to grow other crops for a few years, after which the old process can generally be repeated for a number of years on the same land. In this, as in all other cropping systems in successful operation in the area, one of the most important requirements is to keep up a liberal supply of organic matter.

A system of farming that has maintained crop yields on the farms of a large estate in eastern Maryland offers an example. The records kept by the estate a few years ago showed that crop yields were then about the same as they were 30 years ago—corn, 30 bushels; wheat, 17 bushels; and clover hay 1½ tons per acre. These yields are not large, but they have been maintained for a long period in a section where yields of the same crops on adjoining farms are very much lower. The soil ranges from a sandy loam to a clay loam. The crop rotation practiced is:

| | |
|---|---|
| First year | Corn. |
| Second year | Wheat. |
| Third year | Clover for hay and pasture. |
| Fourth year | Wheat. |
| Fifth year | Clover for hay and pasture. |

All of the wheat and about three-fourths of the corn grown are sold. The hay and one-fourth of the corn are fed, the corn stover and wheat straw are utilized as feed and bedding, and the manure is returned to the land. The manure is spread on the clover sod and turned under for corn. Each wheat crop is fertilized with commercial fertilizer analyzing 2 per cent nitrogen, 8 per cent phosphoric acid, and 2 per cent potash, at the rate of 300 pounds per acre.

The essential difference between the system of farming on this estate and on other farms of the community is not so much in the fertilizer used as in the rotation and disposition of the crops—a 5-field system with two of the fields in clover each year as against a 5-field system with one field in clover each year. The system of renting the farms on this estate encourages the renters to keep livestock and results in all the hay, straw, corn stover, and part of the corn being fed on the farms and the manure returned to the land.

The production of small fruit and truck crops throughout much of the area necessarily makes the cropping system on many farms more or less irregular. But even on farms devoted largely to growing truck and small fruits provision must be made for supplying organic matter to the soil if yields are to be maintained. Organic matter can usually be supplied in such cases by growing winter cover crops of crimson clover, rye, or vetch. These cover crops can be sown after such crops as potatoes, cantaloupes, tomatoes, and also in standing corn, to good advantage. The following 4-year rotation, which provides for growing feed for livestock and for some wheat and truck crops for sale, is well adapted to much of this area and will rapidly improve the land:

| | |
|---|---|
| First year | Corn. Cowpeas sown at last cultivation of the corn to be disked in for wheat. |
| Second year | Wheat. Red clover sown on the wheat in early spring. |
| Third year | Clover cut for hay. |
| Fourth year | One-half in tomatoes, followed by crimson clover. One-half in potatoes, followed by crimson clover. |

Cowpeas are sown in the standing corn at the last cultivation and after the corn is cut the peas are disked in for wheat. If manure is available it should be used as a top-dressing on the wheat during the winter and spring before the red clover is sown. This practice insures a good catch of clover. The following year, or the third year of the rotation, the clover is cut for hay. This leaves a good red-clover sod that can be plowed in the fall for early potatoes and tomatoes the next spring, or the fourth year of the rotation. After these crops are harvested crimson clover is sown to be turned under the following spring for corn. This rotation not only provides abundant organic matter and nitrogen, thus keeping the land in a productive condition, but also gives a fairly even distribution of both man and horse labor.

Numerous other cropping systems are in use and some are effective in building up and maintaining crop production, but these examples illustrate some of the more important features to be considered in formulating systems suited, in whole or in part, to most general farms of the area. In addition to the effectiveness of the cropping system the question of financial returns must be considered, as well as the conditions of the individual farm and the finances of the individual farmer.

## PRACTICAL CONSIDERATIONS

Building up the fertility of the soil is an economic as well as an agricultural problem. Expenditures must be justified by the increase in crop yield either at once or at some time in the near future. The kind of crop grown and the price received are important factors,

since these affect the margin of profit and consequently the amount of money available for improvement.

The rate at which this improvement is to be made must be governed to a certain extent by the amount of capital available for the purpose. If the necessary capital is available, the improvement can be carried on rapidly and the soil built up in a comparatively short time. With little or no capital available more time is necessary and the improvement must be brought about gradually. The latter course has its advantages in that it gives more time for becoming familiar with important details, and invites less danger from losses through putting more money into the soil than returns will warrant. Such losses may occur when the improvement is brought about rapidly.

The type of farming should be made to conform to the conditions on the individual farm. For the man with small capital, crop farm-

FIGURE 5.—Yield too low to pay for the labor, much less to pay a profit

ing is much more simple and more desirable type, for a few years at least, than is livestock farming. A few well-selected cash crops will generally return a reasonable income with less investment than is required for livestock farming. There is an advantage, however, in keeping enough livestock to utilize feed that might otherwise be wasted, the manure being returned to the land. However, all the real advantage in keeping livestock for the manure alone can easily be gained by using small quantities of fertilizer and plowing under green crops. In starting to improve farm land in this area the tendency to rush into livestock farming before conditions warrant the change should be studiously avoided. It is the part of wisdom to increase the livestock gradually as the soil is built up to a point at which an abundance of feed can be produced easily, and as sufficient capital to buy fences and livestock equipment is accumulated. But in the beginning and for a considerable time thereafter, crop

farming and the sale of cash crops have a decided advantage in simplicity of operation and quicker and surer returns

Selection of crops for sale should be based on the experience of the community, taking into account the conditions on the individual farm with reference to character of soil, labor supply, and other factors. Whatever the choice may be, whether truck crops and small fruits that require heavy applications of commercial fertilizer, or hay and grain not so heavily fertilized, it will be advisable to include clovers and other soil-building legumes in the cropping system.

## EXAMPLES OF SOIL IMPROVEMENT

The examples of soil improvement given in the following pages have been selected from among a large number of farms on which

FIGURE 6.—Crimson clover has increased the yield of corn from 12 bushels to 50 bushels per acre in five years

the crop yields have been increased by making the land more productive through the use of legumes and other crops grown to add organic matter to the soil. The crops and methods employed, with a few of the results obtained on each farm, are briefly described.

### A CORN FARM

The regular practice on a certain corn farm was to grow corn one year in three, allowing the land to "rest" for two years before another crop was planted. During the resting period grass and weeds were allowed to grow up to accumulate fertility for the next crop. Under this system of cropping the yield of corn ranged from 15 to 18 bushels per acre. Figure 5 shows the corn on a part of the farm that was still under this method of cropping when the picture was taken.

The first step in the soil-improving program on this farm was to plow and plant one of the fields to cowpeas. The cowpeas made a fair growth and were cut for hay early in September. The stubble was then disked and seeded to crimson clover. The following spring the crimson clover was turned under and the land was planted to corn. At the last cultivation of the corn, crimson clover was again sown. The following spring the crimson clover was again turned under and the land was planted to corn. This practice was continued for five successive years on the same field. The yield of corn increased from 18 bushels to 40 bushels per acre in three years. The fifth corn crop made a yield of 50 bushels per acre. Figure 6 shows the condition of the corn crop near the end of the fifth year. (Compare with fig. 5.)

FIGURE 7.—A cotton farm. Less than 100 pounds of lint cotton per acre. This land needs organic matter

The fertilizer treatment given the corn was the same in the old and the new system of cropping. Two hundred pounds per acre of 16 per cent superphosphate was applied to each crop of corn. Corn one year in three with 200 pounds per acre of 16 per cent superphosphate, continued for several years, did not increase the yield of corn, whereas corn following crimson clover turned under with 200 pounds per acre of 16 per cent superphosphate more than doubled the yield in five years under the conditions on this farm. The only actual change in cropping system was, first to grow a crop of cowpeas and after that to turn under a catch crop of crimson clover in preparation for the corn crop. Since the fertilizer treatment was the same under each system, the increase in the yield of corn would appear to be due to the beneficial effects of the nitrogen and organic matter supplied to the soil by the crimson-clover crop. Although

these yields are not unusually large, the fact is that these comparatively simple methods, with small additional expense, furnish an excellent example of the possibilities of building up land by turning under crimson clover.

### A COTTON FARM

The soil on a certain cotton farm is typical of the sandy loams of the coastal plain in the southeastern part of Virginia where the farm is located. The principal crops in this section are corn, peanuts, cotton, and soybeans. This farm had been parcelled out to tenants for growing corn and cotton on a share basis. Little or no provision had been made to keep up soil fertility except through the use of small quantities of commercial fertilizer. Under this system of farming the crop yields declined to the point at which tenants no longer found it profitable to work the land and the

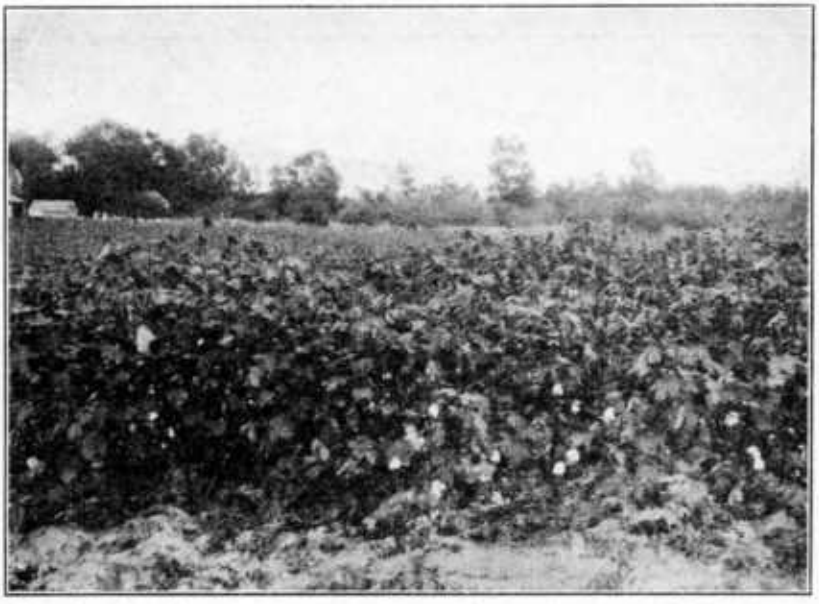

FIGURE 8.—More than a bale of cotton to the acre after growing cowpeas and plowing under one crop of crimson clover

farm changed hands. Figure 7 shows the cotton crop on one of the fields before the soil was improved. (Compare with fig. 8.)

The new owner, with a very limited amount of capital, at once began to improve the soil by growing cowpeas, rye, and crimson clover to be turned under. One field was planted to cowpeas with an application of 250 pounds of superphosphate per acre. The peas were cut for hay and the next spring the land was planted to cotton, with an application of 200 pounds per acre of a 2–8–3 fertilizer. The yield of cotton was one-third of a bale per acre. Another field was planted to rye in the fall and was turned under for corn the following spring. The yield of corn was about 20 bushels per acre.

From this beginning the following 2-year rotation was put in operation:

| | |
|---|---|
| First year | Cotton plus crimson clover after first picking. |
| Second year | Corn plus cowpeas at last cultivation. |

In this rotation crimson clover was sown in the cotton either at the last cultivation or after the first picking, depending on the moisture condition of the soil. Cowpeas were sown in the corn at the last cultivation. The essential difference between this rotation and that previously used on this farm is that cowpea stubble was turned under for cotton and a crop of crimson clover was plowed under for corn each year. This difference in the system increased the yield of cotton from 100 pounds of lint per acre to more than 500 pounds per acre in four years, and the yield of corn from 20 bushels per acre to 40 bushels during the same time. Figure 8 shows the cotton crop of the fourth year just before the first picking.

FIGURE 9.—Wheat yielding but 8½ bushels per acre does not pay in this section

## WHEAT YIELDS ON ADJOINING FARMS

Wheat is not usually a profitable crop on the lighter soils of the coastal plain area, mainly because of its low yields. The crop is grown to some extent, however, to bridge the gap between intertilled crops and the grass and clover that follow in the rotation. The two farms from which figures are used here to illustrate the effect of soil management on the yield of wheat are in Delaware and are separated only by a country road. The soil on these farms is of the same general character, differing mainly in productivity, a difference brought about by the difference in methods of farming.

On one farm the wheat followed corn, as is the usual practice in rotation of corn, wheat, and hay. The wheat had an application of 300 pounds of superphosphate per acre and made a yield of only

8½ bushels. (Fig. 9.) The yield was low because this system of cropping did not supply enough organic matter to keep the lighter soils in a productive condition. Had this rotation been changed to include crimson clover turned under for soybeans followed by wheat, the yields, even on this light land, would undoubtedly have been much better.

The wheat on the other farm was sown in part after a clover sod and in part after early potatoes. The potatoes of the previous year had been fertilized with 1,000 pounds per acre of a 5–7–7½ fertilizer. The wheat itself had an application of 300 pounds per acre of 3–7–7½ fertilizer and made a yield of 30 bushels per acre. (Fig. 10.) This farm furnishes a good example of the efficient use of fertilizer on sandy loam soils in connection with the use of clover and other legumes that keep the soil well supplied with organic matter.

### CORN CONTINUOUSLY FOR 25 YEARS

Another farm furnishes an excellent example of the possibilities of building up the fertility of the soil while the land is producing

FIGURE 10.—Same type of land shown in Figure 9. Thirty bushels of wheat per acre after growing legumes and using a little fertilizer

a crop of corn each year. The soil is sandy with a porous subsoil and had been so reduced in fertility that the yield of corn was only 12 or 15 bushels per acre when the practice of sowing crimson clover in the corn was begun. Corn was grown continuously year after year on the same field for 25 years. Each year crimson clover was sown in the corn at the last cultivation. The following spring the crimson clover was cut for hay and the stubble was plowed under in preparation for the next corn crop. Each corn crop was fertilized with 250 pounds per acre of fertilizer made up of equal parts of 14 per cent superphosphate and kainit. The land was plowed 6 or 7 inches deep and the corn was cultivated to keep down weeds. The yield of corn was increased from 15 bushels to more than 40 bushels per acre. In addition, an average of at least a ton of crimson clover hay per acre was cut annually.

These yields are not large, but the fact that this sandy land was built up by simple and practical methods and the yields have been maintained for so long a period, is of more than passing interest in connection with crop yield. At the time this information was obtained there was no indication of the yields declining. This plan of cropping has been adopted by many other farmers in the community, but the results in most cases do not extend over a sufficient period to show what the standard practice should be.

This farm furnishes a striking illustration of the building up of a poor sandy soil by the addition of organic matter and the judicious use of fertilizers while the soil was yielding a fair financial return each year by a continuous growing of crops. The achievement teaches some valuable lessons in fertility problems in general, and furnishes an example of the effectiveness of fertilizers used with sufficient organic matter. The example is all the more remarkable because on this farm no lime or manure has been applied and only comparatively small quantities of commercial fertilizer have been used. The main secret of this striking success is the fact that the cropping system is so arranged as to keep up the supply of nitrogen and organic matter to a point of fairly high efficiency. Such a system goes a long way in meeting the problem presented by the combination of poor soil and low finances.

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